

REMARKS

Claims 6 and 10-14 have been canceled. Thus, claims 1 and 4 are pending. For reasons stated below, Applicants respectfully submit that the claims of the present application are patentable over the prior art of record. Accordingly, Applicants respectfully submit that the present application is in condition for allowance.

I. Election/Restriction

Applicants confirm the provisional election of claims 1 and 4 (Group I) directed to a Ge-Cr alloy sputtering target for prosecution in the present application. Claims 6 and 10-14 (Group II) have been canceled.

II. Claim Rejections - 35 USC §103(a)

In the Office Action, claims 1 and 4 are rejected under 35 USC §103(a) as being obvious in view of JP 2002-352483 A.

The JP '483 reference published on December 6, 2002 within one year of the International filing date (October 2, 2003) of the present application and within less than two months from the priority date (January 27, 2003) of the priority document of the present application. This document is citable under 35 USC §103(a) since it forms prior art under §102(a). Applicants reserve the right to swear behind this reference should it be deemed necessary.

The JP '483 reference was cited during the International stage of the present application. Applicants explained the differences between the present invention and the sputtering target disclosed in JP '483 in their "Response to the PCT Written Opinion". An English translation of this document was filed in the U.S. Patent and Trademark Office upon national phase entry.

Applicants respectfully request the Examiner to study and consider the arguments for patentability raised in Applicants' "Response to the PCT Written Opinion" in reconsidering the above referenced rejection.

Turning to the rejection, the JP '483 reference discloses a Ge-Cr alloy sputtering target containing 5 to 50% Cr. Table 1 of the JP '483 reference discloses an "Example 1" of a sputtering target that has a density of 99%. It should be noted that the sputtering targets of Examples 2 and 3 of JP '483 fail to fall within the relative density range, 97% or more, required by claim 1 of the present application. In addition, Paragraph No. 0013 of the JP '483 reference states that the "mean particle diameter" of the Ge and Cr powders "are shown in Table 1". The "mean particle diameter" of Cr listed in Table 1 for Example 1 of JP '483 is "100 μ m".

In the Office Action, it is readily admitted that JP '483 clearly fails to disclose the following limitations stated in claims 1 and 4 of the present application:

"that the density variation of said target is within $\pm 1.5\%$ " (claim 1);

"that, in X-ray diffraction, the ratio B/A of the maximum peak intensity A of Ge phase in a 2θ range of 20° to 30° and of the maximum peak intensity B of GeCr compound phase in a 2θ range of 30° to 40° is 0.18 or more" (claim 1); and

"wherein the composition variation in the target is within $\pm 0.5\%$ " (claim 4).

However, in the Office Action, these limitations are ignored from a patentability standpoint because it is concluded that "the process of JP ('483) is identical or substantially identical to the process disclosed in the instant application." More specifically, the Office Action states:

“ ... In the instant case, the Ge-Cr alloy sputtering target of JP ('483) is identical or substantially identical to that of the instant disclosure and both sputtering targets are produced by identical or substantially identical processes, therefore a prima facie case of obviousness exists. *The same density variation, the same B/A ratio and the same composition variation would be expected* in the Ge-Cr alloy sputtering target of JP ('483) as in the claimed Ge-Cr alloy sputtering target.”

Applicants respectfully disagree with the Examiner's conclusion that “the process of JP ('483) is identical or substantially identical to the process disclosed in the instant application”, and therefore, respectfully request reconsideration of this rejection. In addition, Applicants respectfully submit that the sputtering target of JP '483 would **not** have the same density variation, the same B/A ratio, and the same composition variation of the sputtering target of the present invention.

In support of the Applicants' argument, the following four differences between the disclosure provided by JP '483 and the target/process according to the present invention are provided:

- (i) the Cr powder used to produce the sputtering target of Example 1 of JP '483 has a “mean particle diameter” of 100 μ m, not a “75 μ m minus sieve” required by the process of the present invention;
- (ii) the Ge powder used to produce the sputtering target of JP '483 does not have a BET specific surface area of 0.1 to 0.4m²/g as required by the process of the present invention;
- (iii) JP '483 uses wet blending to mix the powders to produce the sputtering target and not dry blending as required by the process of the present invention; and

- (iv) the phases present in the sputtering target of Example 1 of JP '483 contain a Cr rich Ge-Cr phase (Cr_3Ge) which is clearly different from that of the sputtering target of the present invention.

“Mean Particle Diameter” vs. “Minus Sieve”

Table 1 of JP '483 discloses a “mean particle diameter” of the powders used to produce the sputtering target. See Paragraph No. 0013 and Table 1 of JP '483.

The phrase “mean particle diameter” is used to define the average size of the particles of the powder. The powder will possess a certain particle size distribution, and there will be variation in the size of the particles. Accordingly, some of the particles will be greater than the average size and some will be less. As an example, if the powder has a mean particle diameter of $100\mu\text{m}$, particles having a diameter both greater and less than $100\mu\text{m}$ will be present and tolerated. Thus, particles of $125\mu\text{m}$ or more will be present and tolerated in the Cr powder of Example 1 of JP '483.

In contrast, the present invention requires use of a powder having a “minus sieve” particle size. See page 5, lines 11-14, of the present application, as filed. Thus, for a powder having a $75\mu\text{m}$ minus sieve, particles having a size greater than $75\mu\text{m}$ do not exist. Only particles of a size of $75\mu\text{m}$ or less exist in the Cr powder from which the sputtering target of the present invention is produced.

Particle size effects sintering reaction. The present invention uses a Cr powder having a $75\mu\text{m}$ minus sieve thereby defining an upper limit to particle size for purposes of controlling reactive sintering of the Cr and Ge powders. In the present invention, the presence of Cr powder of a size greater than $75\mu\text{m}$ will cause the reaction to become uneven thereby causing variations

in the density and composition of the sputtering target. Ge powder and Cr powder have different specific gravities, the latter being less. The powders must be evenly dispersed to produce a sputtering target with uniform density and composition required by the claims of the present application.

If the sintering reaction is permitted to be uneven, the sputtering target will include coarsened hetero-phase grains and will cause the generation of nodules and particles during sputtering deposition. The target of the present invention is primarily used for forming a nitride thin film by reactive sputtering. If there are coarsened hetero-phase grains in the sintered target, the coarsened hetero-phased grains will inhibit the formation of the nitride thin film when attempting to form such nitride thin film by reactive sputtering making it impossible to form a nitride thin film with the desired uniform density, composition, and thickness.

For at least the above stated reason, Applicants respectfully submit that the process of producing a sputtering target according to JP '483 is neither identical nor substantially identical to the process required by the present invention. Accordingly, the process according to JP '483 would not produce a sputtering target having the density variation and composition variation required by claims 1 and 4 of the present application. JP '483 merely requires the use of Cr powder having a mean particle diameter. It fails to disclose the use of a Cr powder with a 75 μ m minus sieve or the importance of defining an upper limit of Cr powder particle size. Example 1 of JP '483 uses a Cr powder with a mean particle diameter of 100 μ m. Examples 2 and 3 of JP'483 fail to disclose sputtering targets having a relative density of 97% or greater and their use of a Cr powder having a mean diameter size of 50 μ m would include particles of a size greater than 75 μ m.

Accordingly, Applicants respectfully request reconsideration and removal of the obviousness rejection of claims 1 and 4 of the present application based on JP '483.

BET Specific Surface Area

JP '483 fails to provide any information concerning BET specific surface area of the powders used to make the sputtering target or the importance thereof.

The present invention requires use of a Ge powder having a BET specific surface area of 0.1 to 0.4m²/g. See page 5, lines 13-16, and page 6, lines 14-16, of the present application, as filed. When converting a BET specific surface area of 0.1 to 0.4m²/g for Ge powder into a grain size, it corresponds to 2 to 11μm and indicates that this powder possesses sinterability corresponding thereto.

The Ge powder used to form the sputtering target of the present invention is clearly different from the Ge powder disclosed in JP '483 which has a "mean particle diameter" of 100μm. A Ge powder having a mean particle diameter of 100μm corresponds to a BET specific surface area of 0.01m²/g, assuming that the powder is spherical. Accordingly, the BET specific surface area of the Ge powder of JP '483 is significantly different from that used to make the sputtering target of the present invention.

Since surface energy provides the driving force of how reaction progresses during sintering, the Ge powder with BET specific surface area required to form the sputtering target of the present invention will favorably advance the reactive sintering of Ge and Cr and the sintering of Ge and Ge to produce a sputtering target having the uniform density and uniform composition required by claims 1 and 4 of the present application. Use of the Ge powder of JP '483 will clearly not produce the same result.

Accordingly, Applicants respectfully request reconsideration and removal of the obviousness rejection of claims 1 and 4 of the present application based on JP '483.

Wet Blending vs. Dry Blending

JP '483 discloses "wet blending" of Ge and Cr powders. For example, see Paragraph No. 0013 of JP '483 which states "Put in this combination powder into the poly pot, carry out *wet blending* for 5 hours, and the metal mold of a hotpress is filled up with the obtained mixed powder." Wet blending causes oxidation. Oxidation makes it difficult to obtain sufficient density and causes other problems.

In contrast, the process of producing the sputtering target of the present invention requires "dry blending" of the powders. For example, see page 7, line 4, and page 10, lines 5 and 25, of the present application, as filed. Dry blending does not present problems with respect to oxidation.

When Ge powder and Cr powder are wet blended according to the process disclosed by JP '483, the surface of the Ge powder will become oxidized. Since Ge is the primary component of the mixture and oxidizes easily, the oxidation on the surface thereof will be significant. The oxide film formed on the Ge powder will inhibit the reaction and sintering between Ge and Ge and between Ge and Cr, and it will be difficult to achieve density and compositional uniformity. In addition, large quantities of oxygen as an impurity will exist in the sintered target which will inhibit the formation of a nitride thin film when attempting to form the film by reactive sputtering. Thus, the nitride thin film itself will neither have uniform density nor uniform composition. Further, oxygen and oxides cause the generation of nodules and particles during sputtering thereby further deteriorating the characteristics of the thin film formed by sputtering.

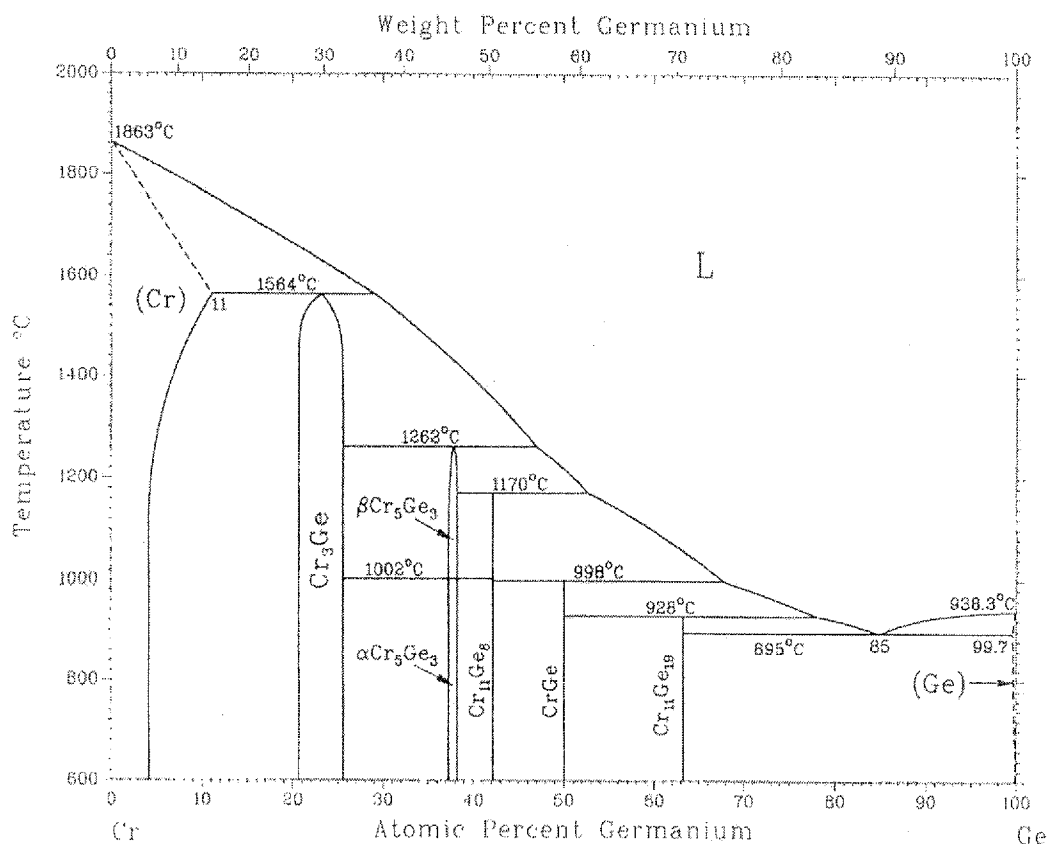
Accordingly, the wet blending process required by JP '483 must not be used if the sputtering target according to claims 1 and 4 of the present application is to be produced. Thus, the structure of the target produced by the method of JP '483 will be different to that of the present invention.

Accordingly, Applicants respectfully request reconsideration and removal of the obviousness rejection of claims 1 and 4 of the present application based on JP '483.

The Phases Produced will be Different

A Ge-Cr phase diagram is shown on the following page. The diagram clearly shows that Cr_3Ge (referred to as a Cr rich Ge-Cr phase) is stable only in a Ge-Cr alloy containing 75-80at% Cr. The existence of a Cr_3Ge phase in the structure of a Ge-Cr alloy sputtering target containing only 5 to 50at% Cr (required by claim 1 of the present invention) suggests uneven sintering of the raw materials Cr and Ge during formation of the sputtering target. Accordingly, a sputtering target containing 5 to 50at% Cr and including a Cr_3Ge phase would not have the same density variation, the same B/A ratio, and the same composition variation required by the claims of the present application. In addition, the process for forming such a Ge-Cr alloy sputtering target (containing 5 to 50at% Cr and including a Cr_3Ge phase) cannot be considered "identical or substantially identical" to that of the present invention.

Assessed Cr-Ge phase diagram.



In the target of the present invention, Ge-Cr compound particles are scattered in the Ge phase. The Ge-Cr compound obtained in the Examples provided in the present invention is Cr₁₁Ge₁₉. On the following page, a Figure is provided showing a comparison of the XRD measured data of a sputtering target of the present invention and data of an ICDD card. As evident from the Figure, the Ge single phase and Cr₁₁Ge₁₉ crystals overlap; thus, the existence of Ge and Cr₁₁Ge₁₉ crystals can be confirmed. There is no peak of Cr₃Ge that matches the data of the ICDD card. This confirms that there are no Cr₃Ge crystals. For the same reason, the Figure also confirms that Cr₄Ge₇ crystals also do not exist in the structure of the sputtering target of the present invention.

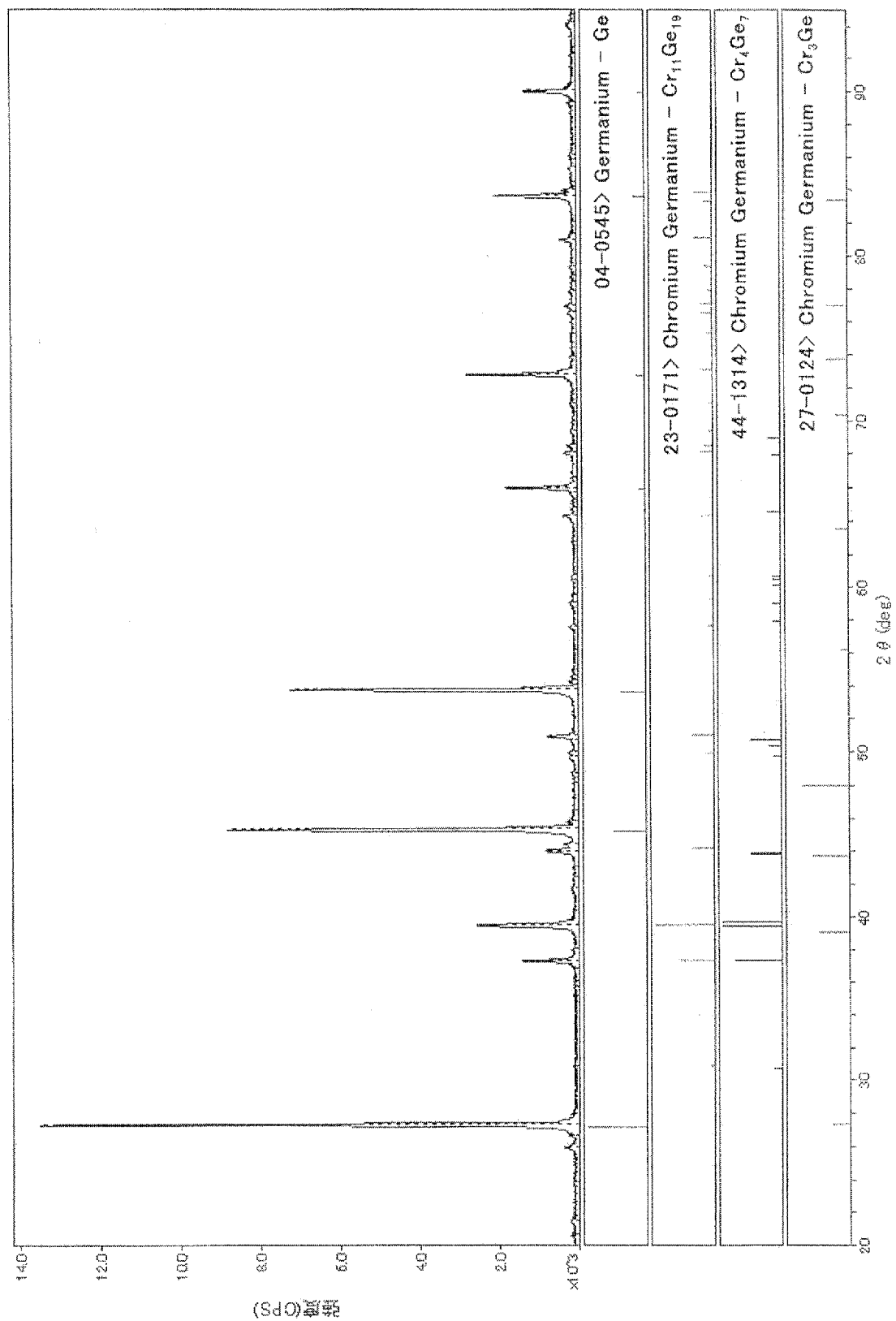


図1. XRD 測定結果

Accordingly, in the sputtering target of the present invention which contains 5 to 50at% Cr, the $\text{Cr}_{11}\text{Ge}_{19}$ compound is detected in x-ray diffraction in a 2θ range of 30° to 40° recited in claim 1 of the present application. A CrGe compound shown in the previously discussed Ge-Cr phase diagram may also be detected.

Turning to the sputtering targets disclosed in JP '483, the compounds for Examples 1 and 2 contain a Cr rich Ge-Cr phase (Cr_3Ge), which clearly provides a different structure relative to that of the present invention which does not include such a compound. The compound obtained in Example 3 of JP '483 appears to include a $\text{Cr}_{11}\text{Ge}_{19}$ phase scattered in the Ge phase. However, the relative density for Example 3 of JP '483 provided in Table 1 is 93%, which clearly falls well below the range required by the claims of the present application (97% or more).

Accordingly, the Ge and Cr raw materials of the sputtering targets of Examples 1 and 2 of JP '483 are not sintered evenly as required by the present invention. The existence of Cr_3Ge in a Ge-Cr alloy target containing 5 to 50at% Cr provides evidence of uneven sintering. Thus, the structure of the sputtering targets of JP '483 are different from that of the present invention and the method of manufacturing the sputtering targets of JP '483 is neither identical nor substantially identical and the same B/A ratio, and the same density variation, the same B/A ratio, and the same composition variation required by the claims of the present application would not be provided by the targets of JP '483.

Accordingly, Applicants respectfully request reconsideration and removal of the obviousness rejection of claims 1 and 4 of the present application based on JP '483.

III. Conclusion

In view of the above remarks, Applicants respectfully submit that the rejections have been overcome and that the present application is in condition for allowance. Thus, a favorable action on the merits is therefore requested.

Please charge any deficiency or credit any overpayment for entering this Amendment to our deposit account no. 08-3040.

Respectfully submitted,
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